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(54) Contact-less electronic connectors

(57) An electronic data transfer system comprising purely capacitive couplings CL1, CL2, CL3 between physically separate units, for example a card and a terminal. Both data and power are transferred, data being extracted 2, by demodulation or decoding from the power supply. Switching means 3 enable data to be input and output through a single capacitive coupling CL3. To provide faithful data transfer with low capacitance coupling values, the capacitive couplings are not permitted to charge. The card may be inserted either way up.

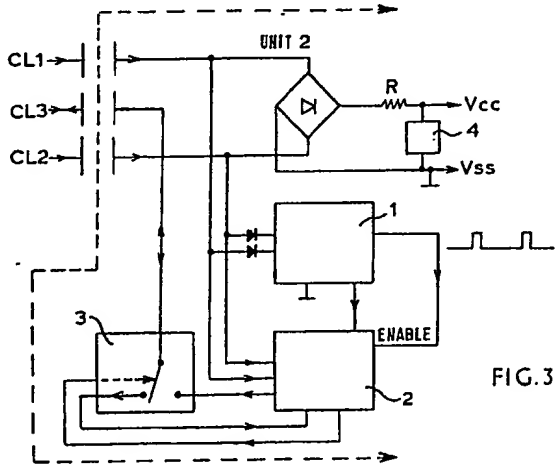
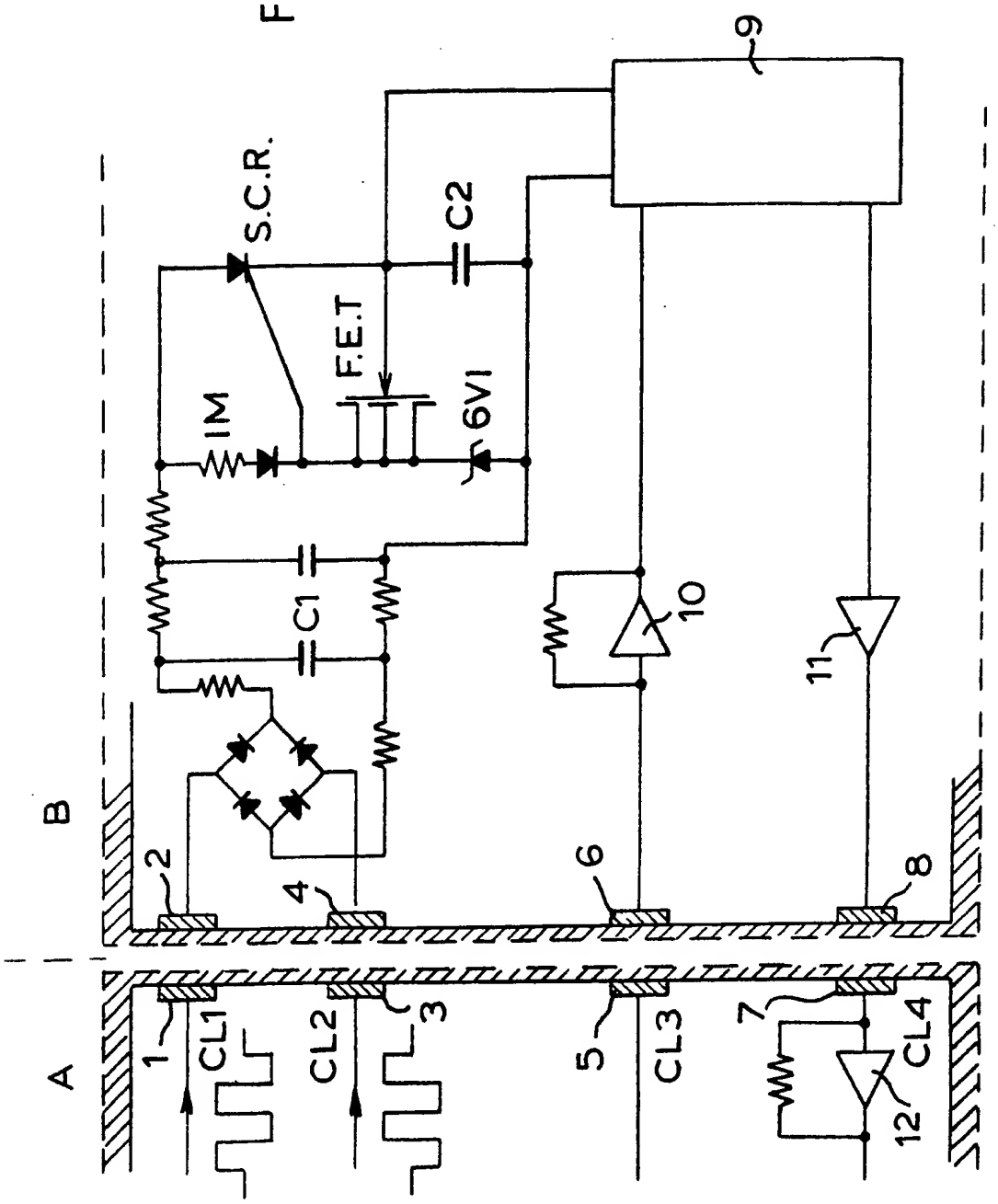


FIG.3

GB 2 149 548 A

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

FIG.1.



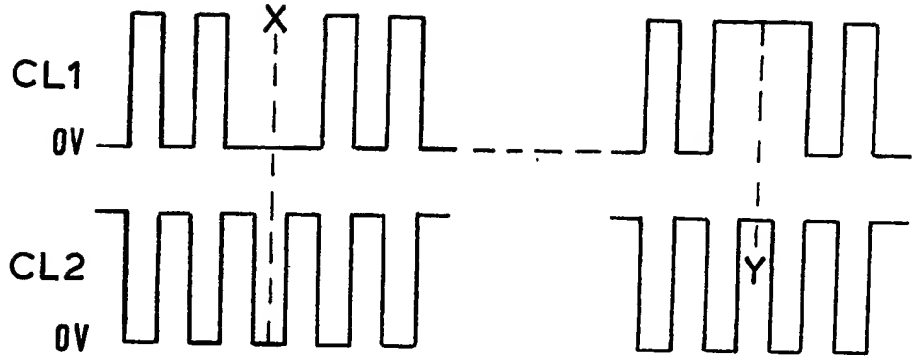


FIG.2.

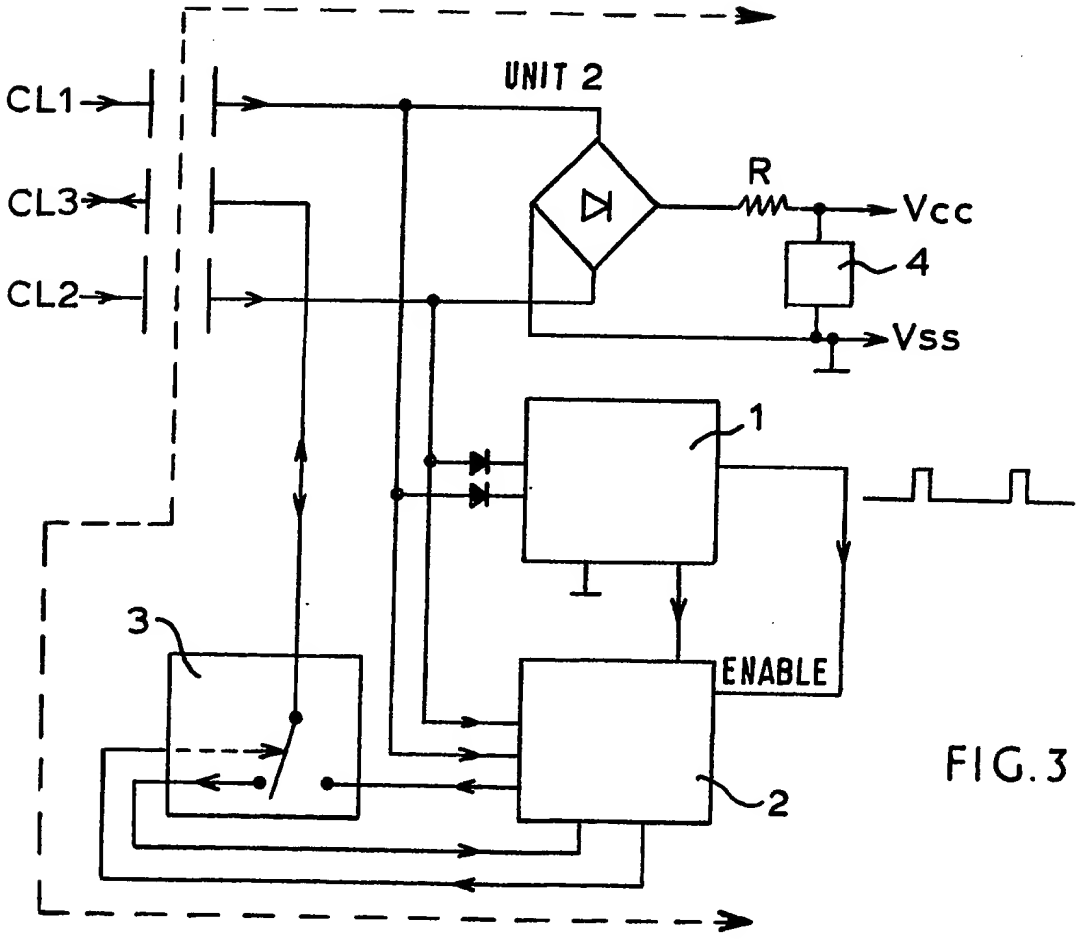


FIG.3

SPECIFICATION

Contact-less electronic connectors

This invention relates to interconnections between electronic assemblies commonly associated with plugs sockets strip-connectors and other direct electrical connections.

The invention is applicable inter alia to electronic cartridges and to electronic credit cards "smart-cards" for cash or credit transfer, security, and so on. Such assemblies comprise boxed or encapsulated integrated circuitry accessed via exposed or nominally concealed metal contacts.

Physical damage corrosion and misalignment of these contacts, also static discharge oil/water ingress and other hazards associated with electronic malfunction, can be substantially avoided by removing the need for exposed metal-to-metal connections altogether.

A known alternative to direct electrical contact is capacitive-coupling.

The present invention is concerned with substantially eliminating certain electrical constraints most particularly associated with small and widely varying capacitance values of couplings which are required to communicate useful energy levels plus faithful analog and digital data signals. This is achieved in principle by exploiting a characteristic of a discharged capacitance element which behaves for an instant like a direct electrical connection when exposed to potential difference across its plates. Current flow at this instant is similar to short-circuit current.

The capacitor begins to charge and current flow diminishes as a function of associated network components. By working a coupling in this maximum charging current region, realistic electronic energy levels and faithful data transfer across electrically insulated barriers, can be achieved.

Accordingly, the invention comprises means to restrict charge levels of couplings, means to rapidly discharge unwanted accumulated charge across couplings, and means to maximise coupling capacitance values more especially where relevant working surface area is restricted.

The above mentioned and other features and objects of the invention and the manner of attaining them, will become more apparent and the invention itself will be best understood by reference to the following description of an imbodiment of the invention taken in conjunction with the accompanying drawings in which:-

Figure 1 shows a part block-diagram illustrating a basic construction with separate power supply and data channels capacitively coupled between two otherwise electrically isolated assemblies.

Figure 2 shows voltage waveforms applicable to couplings cl1 and cl2 of the improved arrangement shown in Figure 3.

Reference is now made to Figure 1 which represents a First electronic assembly (A) likened to the reader surface of a console in proximity to the corresponding surface of a Second assembly (B) likened to a program cartridge or plastic card containing power consuming electronic elements.

Conductor plates 4 and 6 form power supply couplings cl1 and cl2. Plates 5/6 and 7/8 represent one each of pluralities of input and output data channel couplings cl3 and cl4. Block 9 could be a data manipulator and store powered from regulated power supply reservoir C.2.

Functions of respective elements will now be explained:-

Couplings cl1 and cl2 are fed respectively with anti-phase alternating-current or alternately switched direct-current. Frequency of this signal is chosen to only part charge the couplings. Charge current in assembly B is rectified smoothed regulated and stored, shown here using known circuit arrangements.

The salient feature here according to the present invention is the achieved object of supplying direct-current operating elements through low capacitance value couplings.

Input data coupling cl3 of Figure 1 might be a serial data and/or serial addressing channel, or cl3 might be one of pluralities of parallel data and/or addressing channels. Capacitance value of this coupling will likely measure only decades of pico Farads, unsuitable for faithful data transfer if the coupling is permitted to charge. This explains the purpose of current intensifier 10 the output of which is positively fed back to plate 6 of the coupling via a resistance element. Signals on plate 5 are therefor voltage followed by plate 6 with insignificant delay. Potential difference if any across the coupling remains effectively constant, so normal charging of the coupling is prevented from distorting the coupled signal. The salient feature here according to the present invention, is the achieved object of a discharged coupling behaving similarly to a direct electrical connection.

It will be apparent from the foregoing that improved reliability is attained if the data channel coupling plates 5 and 6, are simultaneoulsy forced to similar protocol levels as part of a parity check procedure prior to data transfer.

The data output channel cl4 is self explanatory except for optional current intensifier 11.

Figure 2 of the diagram, in conjunction with Figure 3 represent improved arrangements which enable capacitive couplings to share different functions. It will be plain in the art that fewer couplings enable larger plate areas, simpler construction and less critical alignment requirements.

Figure 2 shows one example of how data and/or instructions can be impressed on power supply waveforms. In this example, pulses X and Y on cl1 are two different instructions when decoded relative to the power supply waveform at cl2. It will be plain in the art that waveform edges during a missing pulse, can be utilised for synchronizing and other purposes. Also that the waveform on cl2 can double as a master-clock. Other combinations of various modulating and decoding practises, will be apparent. The salient feature here, according to the invention, achieves the stated object of reduced numbers of couplings. It also embodies a user benefit not immediately apparent. Function

shared couplings embodied in, for example, an electronic credit card requiring two or even three couplings as described, can be arranged to respond correctly whether the card is up-side-down or wrong-way-round, relative to the card reader surface.

Figure 3 of the diagram, represents one such construction in which Unit 2 is equivalent to assembly (B) of Figure 1. Unit 2 could represent an electronic card or cartridge assembly with three coupling plates (metallic-foil) mounted beneath the surface both top and bottom of a cartridge, or as a single layer sandwiched in the plastic of a card. Coupling cl3 is a two-way data channel centred between couplings cl1 and cl2 the left-hand plates of which are supplied with voltage waveforms described above.

It will become apparent from the following description, how such a construction can be offered up to the reader I "any-way-up" and "any-way-round" such that data can be:- written into, manipulated and stored by Unit 2. Retrieved, modified and rewritten out of and into Unit 2 by the console reader.

Primary functions of blocks 1 to 4 of Figure 3, will now be explained in conjunction with salient features accorded to the present invention thus far.

Energy store 4 is continuously replenished via resistance element R which assists to preserve instructions modulated on power supply waveforms previously described.

Energy store 4 supplies a low-power low duty-cycle oscillator in block 1, which only occasionally enables other power hungry activities. Relatively long energy accumulation periods are followed by bursts of described activities.

Such bursts are triggered to coincide with a Read or Write instruction which will appear to Unit 2 at coupling cl1 or cl2 according to "which-way-round" it is offered up to the Reader. This recognition function is performed in block 1 which informs block 2 from where to derive master-clock edges. Block 2 decodes Read or Write instructions, and prepares the data channel to cl3 accordingly. The salient feature accorded to the present invention here, is the means by which energy is accumulated during long changing periods prior to bursts of purposeful activities, and the means by which a single coupling carries two-way data streams in response to Read or Write commands.

Not shown are undefined data manipulation and store elements which will differ according to the application.

It will be apparent that numbers of couplings can be successfully reduced from three to two, by applying combinations of the principles accorded to the present invention.

CLAIMS

1. What I claim are dual electronic assemblies which mutually communicate electronic data and energy through exclusively capacitive couplings, a first assembly comprising means to couple data-modulated and unmodulated alternating or switched direct current power supply voltages to a Second assembly comprising means to rectify accumulate store and replenish electrical energy, means to extract and decode modulated data from power supply voltages, means to induce a coupling to behave similarly to a direct electrical connection, and means to couple input and output data respectively through a single coupling.

2. Dual assemblies as claim 1 in which means to couple electronic data between assemblies comprises arrangements to restrict capacitive charge between couplings, the preferred but non-exclusive arrangement comprising a current intensifier which continuously drains charge from its coupled input via a resistive positive feedback loop, with additional means to override said coupled input in order to force it to a protocol level as substantially described.

3. A second assembly as claim 1 in which means to replenish electrical energy stores comprises switching arrangements which in a first stage reduce energy consumption for long periods relative to much shorter second states of higher energy consumption.

4. A data transfer system substantially as herein described with reference to the accompanying drawings.

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